Brown-Séquard and M. C. Paul were the earliest to explain the therapeutic value, would find a place in materia medica, nor cultures of microbes. It was not foreseen that we should have to chronicle in 1894 the sale not only of sequardine, but also of veritable bacterial products such as tuberculine, tuberculocidine, antituberculine, antitoxine, *κ.τ.λ.* How shall we check the fury of this flood? There seems no reason why it should ever come to an end.

TRANSPARENT CONDUCTING SCREENS FOR ELECTRIC AND OTHER APPARATUS.[1]

IT is well known that electrostatic instruments require to be screened from outside electric disturbance, in order that their indications may be correct; but it is not so generally recognised that instruments intended to measure small forces, such as certain types of *electro-magnetic* voltmeters, delicate vacuum gauges, &c. are liable to give wrong readings from an electric attraction being exerted on the pointer, such as is produced by the glass cover when it is touched or cleaned.

There is on the table here a well-known type of gravity *electro-magnetic* voltmeter, which may be found on the switch-boards of many English and continental electric light stations. At the present moment its terminals are not connected with the electric light mains of the building, so that it should indicate zero pressure. Let me, however, but stroke the right-hand side of the glass cover with my finger, and the pointer, as you see, at once turns to eighty volts or more. Conversely, let the terminals of the voltmeter be connected with the electric light mains; the pointer should point to about 100 volts, for that, as you know, is the pressure supplied by the Westminster Company. The voltmeter appears to be indicating correctly, but, on stroking the left-hand side of the glass cover, the pressure, as read by the instrument, appears to suddenly fall to some forty volts. And a similiar effect is produced if a piece of wash-leather or dry waste be used in place of the finger.

If, then, it is possible to cause this instrument to indicate at will sixty or eighty volts too high or too low, how impossible must it be to feel sure that the glass cover—which is, of course, maintained in a dry condition in a hot engine room—has not been electrified by some accidental touch of the coat sleeve sufficiently to cause an error of three or four per cent. in the reading of this voltmeter!

We find that it is not merely with this particular type of voltmeter that an error can be produced by stroking or rubbing the glass cover, for other electro-magnetic instruments that we have tried can also have their pointers deflected in the same way, but not to the same extent.

Nor, of course, is this source of error in any way connected with a voltmeter being an instrument constructed to measure an electrical magnitude, for it would equally exist if the glass were clean and dry and the controlling force remained of the same magnitude, no matter what was the quantity the instrument was constructed to measure. For example, on the table there is a vacuum gauge the wheel-sector-pinion of which has been replaced with an Ayrton-Perry magnifying spring. This gauge is, no doubt, very sensitive, for you observe that the pointer moves even when I produce an extremely slight diminution of pressure by rotating the short length of india-rubber tube as slowly as I can; the change of pressure on pinching the tube, or even on dropping it, is indicated by the pointer. On the other hand, the pointer is of glass, and therefore is not suitable for being acted on by an electrostatic force; still, a stroke on the glass cover, as you see, causes the pointer to deflect through several degrees.

It has been known for a long time that it is possible to screen an instrument from such outside electrostatic disturbances by surrounding it with a metallic cage composed of wire or of strips of tinfoil. Such a method of screening, however, has the great disadvantage that it renders it difficult to observe the exact position of the pointer from a distance, for the wires or strips of tinfoil cover up the pointer more or less. We therefore thought of placing the pointer underneath the metallic dial of our electrostatic voltmeters, and of only allowing the tip to project through a slot in the dial plate. But this method we abandoned on trying it eighteen months ago, for to make the screening good the visible part of the pointer must be reduced to a spot, and the exact position of this spot we found less easy to read at a distance of several feet than that of a long black line, which is the appearance of a pointer when it is visible along its whole length. This method of screening has, however, we understand, been recently adopted by a firm of instrument makers.

We next considered whether it was not possible to make a perfectly transparent conducting screen, so that, while the electrostatic screening of the pointer should be practically perfect, the pointer and dial should be as easily seen as if the screen were not present. Our first idea was to make the glass cover double, and to insert between the two sheets of glass a layer of clear conducting liquid. Fearing, however, trouble from leakage of the liquid, or from the liquid becoming gradually turbid and giving the dial a dirty appearance, we turned our attention to depositing films of solid matter on the inside of the glass cover, or shade, of sufficient thinness to be practically transparent, but with the solid particles near enough together to be conducting. We tried smoke, silver deposited in layers of various thicknesses, mercury vaporised and deposited, sal-ammoniac vaporised and deposited, &c., but we were quite unable to obtain in this way both transparency and electric conduction.

After a conversation with Prof. Boys, when discussing the problem that we were then engaged in solving, we commenced experimenting on varnishes, with the view of arriving at a varnish which should be as hard and as transparent as *clear* shellac, but which, instead of being an insulator like shellac, should be a sufficiently good conductor to allow of the instantaneous production of an induced electric charge to balance the electrostatic action of any outside body. Glass plates were coated with gum, with coaguline, with the gelatinous electrolyte used in accumulators (composed of sodium silicate and dilute sulphuric acid), with isinglass dissolved in acetic acid, with gelatine dissolved in acetic acid, with isinglass dissolved in a mixture of acetic and sulphuric acids, and with gelatine dissolved in the same mixture. After much experimenting, we arrived at the following two methods of coating a glass cover, or shade, which gives perfectly satisfactory results:—

No. 1.—Dissolve $\frac{1}{4}$ ounce of transparent gelatine in 1 ounce of glacial acetic acid by heating them together in a water bath at 100° C. To this solution add half the volume of dilute sulphuric acid which has been prepared by mixing 1 part of strong acid with 8 of distilled water by volume, and apply the mixture while still warm to the glass shade, which should be previously polished and be warm. When this film has become very nearly hard, apply over it a coating of Griffith's anti-sulphuric enamel.

Method No. 2.—Thin the gelatine solution, prepared in the manner previously described, by the addition of acetic acid (say 2 volumes of acid to 1 of the solution), and, after polishing the glass, float this thinned solution over the glass cold. Drive off the excess of acetic acid by warming, allow the glass to cool, and repeat the floating process, say, twice. Thin the anti-sulphuric enamel by the addition of ether, and float it over the gelatine layer applied as just described. Expel the ether by heating, and apply a second layer of this thinned anti-sulphuric enamel.

With experience, such as Messrs. Elliott and Messrs. Paul have at length acquired after much practice, a layer can be applied, either according to method No. 1 or No. 2, so that, when finished, it is quite hard to the touch, and so transparent that it is only by looking at the glass plate obliquely that the presence of the varnish can be detected. It is also so conducting that when a P.D. of several thousand volts, alternating with a frequency of 200, is set up between the needle and inductors of one of our electrostatic voltmeters, the pointer, which is metallically part of the needle, is not visibly attracted by a metallic rod held just outside the glass close to the pointer, this metallic rod being electrically connected with the stationary inductors.

Without experience, however, it is somewhat difficult to apply the coating so that it is not either cloudy, or a comparatively poor electrostatic screen, or both.

This second electro-magnetic voltmeter—which, like the former, has been kindly lent us by Mr. Barley, of the Knightsbridge electric light central station—looks exactly like the other one, and, indeed, behaved exactly like the other one when we received it. It has, however, had a layer of our transparent varnish applied on the inner side of the glass subsequently, and you will find that you may rub the glass as much as you like, or even hold a rubbed

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[1] A paper by W. E. Ayrton, F.R.S., and T. Mather, read at the Institution of Electrical Engineers on April 12.

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stick of ebonite near it, without producing any effect on the pointer.

Again, these two clear glass shades, belonging to gold-leaf electroscopes, are one of them coated with our varnish, and the other not. Which is the uncoated one is at once apparent from the alteration produced in the deflection of the gold leaves when I approach a stick of rubbed ebonite near the lower part of the glass shade of the uncoated one, for no such change in the deflection is produced, as you see, when the ebonite rod is brought near the glass shade, which is protected by a layer of this varnish applied on the inside.

THE CURRENTS IN THE GREAT LAKES OF NORTH AMERICA.

A PAPER, entitled "The Currents of the Great Lakes," prepared by Prof. Mark W. Harrington, from data collected by means of bottle-papers during the navigation seasons of 1892 and 1893, has just been published by the U.S. Department of Agriculture as a Weather Bureau *Bulletin*. We reprint some of the more interesting parts of the paper, and reproduce a map showing the results of the inquiry.

Early in 1892 the Weather Bureau published a wreck chart of the Great Lakes, prepared in the winter of 1891–92. The wrecks noted on this chart were only those due to meteorological agents, and a striking feature of the chart was the clustering of wrecks in certain parts of the surface of the lakes. This suggested that unknown currents might play a considerable part in wreckage, and steps were at once taken to get some idea of what these currents are.

The method pursued was that of bottle-papers, which have frequently been used to study ocean currents, but had not been employed in the lakes, and is as follows:—A bottle, containing a paper on which is written the time and place of floating, is thrown overboard at some definite point, left to float freely, and when picked up the enclosed paper is marked with the time and place of finding. In this way two points in the line of current are obtained, and by considering a very large number of these, satisfactory conclusions can be drawn as to the currents which convey the bottles.

A large number of bottles were specially made for this purpose, with the name of the Bureau blown into the glass. They were of an unusual colour, but the contents could be easily seen by anybody who picked them up. The weight of a bottle was about 420 grams; total external displacement, 460 cubic centimetres; volume displaced when floating, 430 c.c.; volume exposed above water, 30 c.c.

From the position of flotation it appears that enough of the bottle was above the surface of the water to give the wind some power in drifting it. This would probably make little difference with the direction of the drift, for the wind that drifted the bottles would drift the surface water in the same direction. It may have made some difference in the speed with which the bottles travelled, making them move, perhaps, faster than the water, but this effect would be slight. Within each bottle a franked envelope was placed, addressed to the chief of the Weather Bureau, at Washington. Before a bottle was thrown overboard a blank form in the envelope had to be filled up, giving the name of the vessel and its captain, the date of floating, and the place where floated. Another space was left for the finder to insert similar data.

The bottles actually picked up were, for the most part, on shore, very few of them having been found in the water. It is impossible to say what proportion of the bottles was recovered, but it was not great. Though probably more than five per cent., it did not exceed ten per cent. The figures cannot be given exactly, because it is not known how many of the bottles are still in the hands of masters of vessels. A considerable portion of the papers recovered was found on the Canadian shore, and, curiously, a large number of them came from shores which are for the most part uninhabited.

The investigation covers the years 1892 and 1893, but it must be remembered that the observations could be taken only during the season of navigation. This practically limits the conclusions to the summer months, as when the bottles are floated in the spring they will probably be found in the autumn, and those that are floated in the autumn will be lodged in ice, and their routes be variously changed, so that trustworthy conclusions cannot be drawn from them. In general, the finds of the latter sort—that is to say, the finds of bottles floated in the autumn and picked up in the spring—have been left out of consideration. The currents shown in the accompanying map are herefore those of the season of navigation, and practically the currents of summer.

CLASSIFICATION OF THE CURRENTS.

The currents in the Great Lakes can be grouped under the four following heads:—

(1) *The Body Currents.*—These lakes all have an outflow, and there must be a general motion of the water towards the outlet. This is visible upon the map of each lake, and the currents which result from it must be continuous throughout the year, and must affect most of the water.

(2) *A Surface Current due to the Prevailing Winds.*—That the winds have great effect on the currents in large bodies of water is widely recognised, and the more constant they are the more marked is the effect. The westerly winds, in case of lakes lying nearly east and west, cause a surface current from the west which is in the same direction as the body current. In the case of the lakes which lie across the direction of the wind, the surface drift is from the west across the lake. The details of the direction, however, depends on where the outlet is, on the form of the lake, and on the position of the inlet.

(3) *The Return Currents.*—It will be seen from the illustration that, in the case of three of the lakes, the main currents hug one shore. In the case of Lake Superior, it is on the southern shore; in the case of Lake Michigan, it is on the eastern shore; and in that of Lake Huron, it is on the western shore. Lakes Erie and Ontario do not show this phenomenon so plainly. This feature can be explained by the two sorts of currents already mentioned, combined with the lay of the lakes as to the prevailing direction of the wind and the position of the outlet. In any case, however, the drive of the water from one end of the lake to the other necessitates more or less a return current, providing the outlet is not sufficiently large to allow this water to pass through. In the Great Lakes, the outlets are comparatively small, hence in all these cases there are return currents.

(4) *Surf Motion.*—Owing to this motion, the bottles have been found to show a decided tendency shoreward whenever they came within its vicinity, and especially so when the water was shallow.

VELOCITIES OF THE CURRENTS.

The directions of currents can be ascertained with much more precision by means of bottle-papers than can the velocities. It has therefore been very difficult to arrive at any satisfactory conclusions concerning the speed of the currents in the Great Lakes. In a general way, the speed appears to vary from four to twelve miles a day. In a few special cases, very much higher velocities have been found, but these are probably due to surf motion rather than the motion of the surface water as a whole. It is not at all improbable that the general surface motion of the lakes has a higher velocity than from four to twelve miles a day, but the only conclusion which it seems safe to draw from the data is that the velocities are at least as high as the figures mentioned.

LAKE SUPERIOR.

In this lake thirty-five bottles were recovered in 1892, and the same number in 1893. From the courses of the bottles it appears that there is a general surface current along the south shore of the lake, from the Apostle Islands eastward, and that to the east of Keweenaw Point this eastern current has very great breadth. Still further eastward, toward the eastern end of the Lake, it spreads out in a fan-shaped way, and a branch of it seems to pass to the northward and westward, reaching the extreme northern coast of the lake. A branch of this current also turns southerly round Keweenaw Point, and at the bottom of the bay, on the south coast of the lake, an eastern current is taken up, which joins the main current to the eastward of Marquette, Michigan. The minimum velocity of the main eastward current of the lake appears to be from four to six miles a day.

LAKE MICHIGAN.

In this lake 163 bottles were recovered in 1892, and thirty-five in 1893. The currents indicated by the floating of the bottles are of unusual interest. There is first a

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